100201

DRAFT
WORK PLAN FOR
BIOREMEDIATION TREATABILITY TESTING
FOR THE
STANDARD CHLORINE OF DELAWARE, INC.
DELAWARE CITY, DE SITE

December 1992

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PREFACE

The Feasibility Study (FS) for the Standard Chlorine, Delaware site is nearing completion with a February 12, 1993 deadline for submittal to DNREC and U.S. EPA. As part of the technology screening step, WESTON identified bioremediation as a possible candidate technology for soils and sediments. Scientific literature and data indicate that biodegradation of chlorobenzenes is technically possible. However, there is little field information on the success or effectiveness of biodegradation for chlorobenzenes in soils. Biodegradation is an attractive potential technology for the Standard Chlorine site but information is not sufficient for technical evaluation of this option.

In order to obtain site-specific data as input to the FS decision making, WESTON will be conducting Phase I screening level treatability testing as presented in this Test Plan. The primary objective of this bench scale testing is to determine the potential viability of the bioremediation technology for treating soils/sediments at the Standard Chlorine site. The test results will be included as an addendum to the FS and if they are favorable, additional testing may be recommended to further advance this technology and quantify design, operating and performance parameters.

The Test Plan for this treatability screening has been prepared as a concise technical document to focus on the basic elements of the planned testing. The Health and Safety Plan for sample collection and testing will be the same as the approved plan used for the RI. Similarly, the QAPjP for the sampling and analysis activities will be the approved QAPjP used for the RI. All analytical testing for chlorobenzenes for this treatability work will be performed by the Standard Chlorine plant laboratory.

Due to the schedule of the FS submittal and the importance of this treatability work, it will be initiated as soon as possible. A lengthy time period for review of this Test Plan will not be possible and we request all reviewers to concentrate on the main technical components of this work in the context of a Phase I screening study. We request all comments within one week following receipt of the document.

SECTION 1

INTRODUCTION

The purpose of this work plan is to outline the activities that will be conducted for the completion of a treatability study intended to assess the viability of biological treatment of the soils and sediments located at the Standard Chlorine of Delaware, Inc. (SCD) Delaware City, Delaware facility. This treatability study is part of the ongoing remediation activities which have been performed by Roy F. Weston, Inc. (WESTON®) for SCD.

In accordance with the Consent Order between the Delaware Department of Natural Resources and Environmental Control (DNREC), and SCD, a Remedial Investigation/Feasibility Study is being conducted at the facility. The Remedial Investigation (RI) is currently under review by the DNREC and the EPA, and is expected to be finalized shortly. This treatability study is being conducted in conjunction with the Feasibility Study (FS) to provide site-specific technology performance data to facilitate evaluation of the technology.

1.1 TREATABILITY STUDY OBJECTIVES

Information obtained and evaluated during the RI has indicated that previous accidental releases of chemicals at the site have impacted several media including: surface soils, subsurface soils, sediments, and groundwater. The primary contaminants of concern at the site are chlorinated benzenes (monochlorobenzene through hexachlorobenzene), with 1,4-dichlorobenzene generally present at the highest concentrations. SCD is currently engaged in groundwater extraction and treatment to limit the migration of contamination through groundwater.

A screening of potential remedial technologies has been performed as part of the FS and indicates that a limited number of treatment options exist for the solid materials, specifically soils and sediments. The screening of potential technologies has further suggested that biological treatment of these solid materials may offer an attractive means of remediation.

Further investigation, including an extensive literature search, has indicated that biological treatment has been shown to reduce the toxicity and/or concentration of chlorinated benzenes.

The objective of this treatability study is to evaluate the technical feasibility of utilizing biological treatment to remediate the soils and sediments at the site. The treatability study will further evaluate the differences between aerobic and anaerobic treatments to determine the resultant reductions in the toxicity and concentration of the contaminants in the soils and sediments. The treatability study will also include column testing to determine the potential for in situ soil flushing/bioremediation of the unsaturated zone at the site.

1.2 SCOPE OF WORK

Several tests will be performed during this treatability study to examine the different potential applications of biological treatment. Batch biotransformation under aerobic and anaerobic conditions, and column tests will be performed. The batch biotransformation test will be performed on three different soils: one surface soil, one subsurface soil, and one sediment. The column test will be performed on a subsurface soil. The subsequent sections of this work plan describe in more detail the performance of these tests.

SECTION 2

REMEDIAL TECHNOLOGY DESCRIPTION

Based upon recent literature and experience, as summarized by WESTON for SCD[1], two possible approaches exist for biological treatment of chlorinated benzenes: (1) anaerobic treatment, by reductive dechlorination, primarily to transform higher substituted chlorinated benzenes to lower substituted, less toxic, and/or more volatile forms, and (2) aerobic treatment to degrade primarily lower substituted chlorinated benzenes to mineral products. As indicated in that review, each of these approaches is suitable for certain types of chlorinated benzenes, and where contamination with multiple components exists, it may be necessary to combine these approaches with each other or with other technologies to achieve treatment goals.

In many cases, microorganisms may mineralize, or completely degrade, organics in the presence of oxygen to mineral products (i.e., CO_2 and H_2O, hence the term mineralization). Aerobic biodegradation has been demonstrated for some chlorinated benzenes, in which case the end products also include chloride, Cl[2,3,4]. In general, the ability to be aerobically mineralized lies primarily in the simpler chlorinated benzenes, notably monochlorobenzene (MCB). Some of the more highly substituted chlorinated benzenes appear to be relatively resistant to aerobic biodegradation. However, at least some of the tetrachlorobenzenes also appear to be aerobically biodegradable[2].

Investigations to date have also shown that the microorganisms primarily responsible for degradation of chlorinated benzenes belong to common microbial groups. In particular, members of the genus *Pseudomonas* have frequently been identified, although the action of some of these organisms is specific to particular types of chlorinated benzenes[2,3]. *Alcaligenes* species have also been identified[3]. It appears reasonable to suggest that appropriate microorganisms may be obtained directly from site soils and/or from other common sources such as biological waste treatment facilities. In at least one instance the addition of microbial seed did not improve treatment rate or efficiency as compared to the activity of indigenous organisms[4].

It is also noted that field-scale implementation of bioremediation of chlorinated benzenes has not been widely demonstrated. In addition, site-specific factors related to soil characteristics and hydrogeology may affect the ability to bioremediate contaminated media in particular instances. Therefore, independent upon the type of remedial action specified (e.g., in situ or ex situ treatment, water or solid matrix), site-specific treatability testing would be required for such purposes.

A growing body of data documents the ability of anaerobic microorganisms to remove chlorine atoms from (dechlorinate) chlorinated benzenes. Due to the specific reactions involved, this phenomenon has been termed reductive dechlorination. The removal of chlorine atoms from a multichlorinated molecules is often quite specific; that is, chlorine atoms are removed preferentially at selected locations on the molecule. In many cases complete dechlorination (removal of all chlorine atoms) is not achieved. Rather, the end products are lower chlorinated organics. Even though complete degradation is not achieved, reductive dechlorination could potentially be applicable as a remediation component for the following reasons:

(1) The lower chlorinated products are generally of lower toxicity than the parent molecule.

(2) The lower chlorinated products are generally more amenable to subsequent (i.e., aerobic) treatment, even when the parent molecule was not.

All of these general principles regarding reductive dechlorination have been observed for various chlorinated benzenes[5,6]. As with aerobic treatment, suitable microorganisms can generally be obtained from common anaerobic environments, including anaerobic or anoxic soils and anaerobic digesters at waste treatment plants[5]. Removal of chlorine atoms from the benzene ring is specific and occurs preferentially at locations where chlorine atoms are at adjacent positions on the ring[5,6]. Thus, hexachlorobenzene forms primarily 1,3,5-trichlorobenzene, while 1,2,4-trichlorobenzene preferentially forms 1,4-dichlorobenzene. In some cases, it appears that dechlorination ceases when there are no remaining pairs of adjacent chlorine atoms[5]. However, other research indicates that further dechlorination may proceed (at lower rates) with the final product being monochlorobenzene[6].

Anaerobic treatment could potentially be applicable as a component for bioremediation of chlorinated benzenes, primarily for complex chlorinated benzenes, such as 1,3,5-trichlorobenzene[6], which are resistant to direct aerobic degradation. In such a case, an anaerobic step would be used to convert the resistant molecules to monochlorobenzene, with a subsequent aerobic step to mineralize monochlorobenzene to CO_2, H_2O, and Cl[8].

Recent research has indicated that degradation of chlorinated organics may be aided by the addition of supplemental carbon sources[7,8,9] under both anaerobic and aerobic conditions. Most of the work to date has focused upon chlorinated solvents using carbon sources such as toluene[7], propane and methane[8,9]. Potential effects of these supplemental carbon sources may include serving as electron donors or cometabolic substrates[7] and/or to stimulate specific microbial populations having particularly effective enigmatic capabilities[8]. While the use of toluene as an amendment may pose some concern for site cleanup, the use of methane may be implementable, and work on the potential field application of methane has recently been presented[9]. Progress in this area will be considered in final implementation of this test plan.

SECTION 3

TEST GOALS

3.1 GOAL

The goals of this treatability testing program will be to evaluate whether biological treatment of soils containing chlorinated benzenes at the SCD site is technically feasible. Technical feasibility will be assessed by determining whether biodegradation/ biotransformation occurs under specified test conditions and the degree to which the required transformations occur. The rate of degradation and concentration reductions over time will provide a preliminary assessment of the feasibility of using biological treatment at the SCD site.

3.2 GENERAL APPROACH

This treatability study will evaluate separately the possibility of achieving anaerobic and aerobic biotransformation of chlorinated benzenes in SCD soils, using a variation of the "multiple flask" approach to provide efficient screening of various treatment conditions. Post-treatment characterization data will be used to evaluate the potential requirements for sequential and/or additional treatment steps. Testing of sequential treatment schemes is not provided in this treatability testing program.

The flask tests will provide a preliminary assessment of whether the necessary transformations can be achieved in SCD soils and will also indicate whether such treatment for excavated soils is feasible. Since the feasibility of in-situ treatment is dependent not only upon the biodegradability of target constituents, but also upon hydrogeologic conditions of the site, column studies will also be conducted to provide an assessment of the feasibility of in-situ soil flushing/treatment.

Performance criteria for these treatability tests will be based upon the extent/degree of biotransformation achieved at specified time intervals, as compared to experimental controls.

3.3 LEVEL OF TREATABILITY TESTING

Treatability tests to be conducted in this program are considered to be preliminary feasibility tests, intended for use in screening of potential remedies. These tests are not intended to provide definitive data for optimization, remedial design, or final data on attainable treatment concentrations.

SECTION 4

EXPERIMENTAL DESIGN AND PROCEDURES

4.1 BATCH BIOTRANSFORMATION TESTING

Treatability tests will be conducted at WESTON's Environmental Technology Laboratory (ETL) in Lionville, PA. Chemical analyses for chlorinated benzenes will be provided by Standard Chlorine of Delaware. Analyses for other chemical parameters will be provided by WESTON's Eastern U.S. Analytical Laboratory in Lionville, PA.

4.1.1 Approach

This treatability test will be conducted by establishing various anaerobic and aerobic test conditions using soils from the SCD site and assessing the extent of biotransformation/ biodegradation over time.

Three soil samples (sediments, surface soils, and subsurface soils) from the SCD site will be used. Each soil will be tested anaerobically and aerobically. Under each condition, three treatments will be tested: inhibited, nutrient amended, and nutrient amended/inoculated. The nutrient amended treatment will evaluate the transformation achievable by naturally occurring microorganisms under optimal conditions using selected nutrient formulation. The nutrient amended/inoculated treatment will evaluate the transformation achievable with supplemental microorganisms. The source of microbial seed for the inoculated anaerobic and aerobic treatments will be mixed microbial populations from anaerobic and aerobic components of a biological wastewater treatment plant. The inhibited treatment will serve as the control against which performance of the amended treatments will be measured. The matrix of test conditions is illustrated in Table 4-1.

Table 4-1

Flask Test Matrix

	Test Condition	Test Treatment	Sampling Frequency[1]
SCD Sediment Sample	Aerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60
	Anaerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60
SCD Surface Soil Sample	Aerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60
	Anaerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60
SCD Subsurface Soil Sample	Aerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60
	Anaerobic	Inhibited Control Nutrient Amended Nutrient Amended/Inoculated	T = 0, 10, 30, 60

[1]Triplicate analyses for chlorinated benzenes at each sample point by SCD.
T = Time in days.

4.1.2 Aerobic Biotransformation Testing Procedure

Aerobic treatments will consist of soil/water slurries with appropriate amendments, loosely stoppered and agitated on a shaker table to provide aeration. All treatments will be tested at room temperature (approximately 20°C).

Three aerobic treatments (inhibited control, nutrient amended, and nutrient amended/inoculated) will be prepared simultaneously from each test soil. The inhibited control will be prepared by adding mercuric chloride to the test flask. The nutrient amended treatment will be prepared by adding soluble fertilizer to provide a target carbon to nitrogen ratio (C:N) of 20:1 and a carbon to phosphorus ratio (C:P) of 100:1.

The nutrient amended/inoculated treatment will be prepared by adding microbial biomass from an activated sludge wastewater treatment plant to the test flask. A sludge sample will be obtained from return activated sludge (RAS) at the WWTP, or if necessary, from the mixed liquor basin. The sludge will be dewatered by settling/filtration to remove the aqueous wastewater fraction. The biomass will be washed with buffer and filtered again to remove residual wastewater constituents. The dewatered sludge will be added to the test flask to provide a soil to sludge ratio of 10:1 (i.e., 10% of the solid matrix will consist of sludge on a volume basis). All treatments will contain a phosphate buffer to control pH.

Performance will be assessed by analyzing slurry samples at the following intervals: Day 0, 10, 30, 60. Each sample will be analyzed for chlorinated benzenes, nutrients, and chlorides. For these treatability studies, triplicate analyses of chlorinated benzenes will be conducted. Chlorinated benzenes analyses will be performed by SCD. Single analyses of nutrient and chloride will be conducted by WESTON for each interval. The matrix of test conditions for each test soil sample is illustrated in Table 4-1.

4.1.3 Anaerobic Biotransformation Testing Protocol

Anaerobic treatments will consist of soil and water slurries with appropriate amendments to foster anaerobic activity. The overall treatment schedule is analogous to that used for aerobic testing, with experimental equipment and procedures modified to permit the attainment and maintenance of anaerobic conditions. Anaerobic treatments will be tested in sealed glass serum bottles[2,5]. Teflon-lined seals will be used. The serum bottles will be incubated at room temperature in the dark and gently swirled periodically to mix the contents.

As with aerobic testing, three anaerobic treatments (inhibited control, nutrient amended, and nutrient amended/incubated) will be prepared simultaneously from each test soil.

The inhibited control will be prepared by adding mercuric chloride to the test flask. The nutrient amended treatment will be prepared by adding soluble fertilizer to provide a target carbon to nitrogen ratio (C:N) of 20:1 and a carbon to phosphorus ratio (C:P) of 100:1.

The nutrient amended/inoculated treatment will be prepared by adding microbial biomass from an activated sludge wastewater treatment plant (WWTP) to the test flask. A sludge sample will be obtained from a primary anaerobic digester at the WWTP, or if necessary, from a secondary or combined anaerobic digester. The sludge will be dewatered by settling/filtration to remove the aqueous wastewater fraction. The biomass will be washed with buffer and filtered again to remove residual wastewater constituents. The dewatered sludge will be added to the test flask to provide a soil to sludge ratio of 10:1 (i.e, 10% of the solids matrix will consist of sludge on a volume basis). All treatments will contain a phosphate buffer to control pH.

Performance will be assessed by analyzing slurry samples at the following intervals: Day 0, 10, 30, 60. Each sample will be analyzed for chlorinated benzenes, nutrients, and chlorides. For these treatability studies, triplicate analyses of chlorinated benzenes will be conducted. Chlorinated benzenes analyses will be performed by SCD. Single analyses for nutrient and

chloride will be conducted by WESTON for each sample interval. The matrix of test conditions for each test soil sample is illustrated in Table 4-1.

4.2 COLUMN TESTING

4.2.1 Approach

Soil column testing will be conducted to simulate the potential for anaerobic in-situ soil flushing/bioremediation of the unsaturated zone at the SCD site. One column test will be conducted. Soils from the site will be packed into laboratory leaching columns to values approximating field density and subjected to constant head flushing with potable tap water. The pH of the tap water will be adjusted, if necessary, to match that of the site groundwater. Nutrients will be added to foster microbial activity. A control column will be used, employing tap water without amendments.

Water samples will be taken from the column inlet and outlet, and contaminant concentrations evaluated over time. Sample frequencies will be the same as used in the batch study. The laboratory will monitor pH, specific conductance, and COD frequently throughout the testing. At the conclusion of the test, soil samples will be taken from the finished columns at depth intervals for comparison of contaminant profiles to pretesting conditions.

An attempt will be made to simulate a specific time period under anticipated full scale remediation operating conditions. Estimates will be made for total anticipated rate of water recirculation, total soil surface area to be utilized for recharge and length of remediation system operation. These estimated values will be used to calculate a hypothesized loading rate for full scale soil flushing which can then be used to create an accelerated study, simulating 10 years of full scale discharge operation in two month period. If this accelerated study goal cannot be met, the study will still be terminated after two months, with an estimate made as to the simulated full scale operation time represented by the study.

4.2.2 Soil Column Test Procedure

A schematic of the column test apparatus is presented in Figure 4-1. A 4 inch diameter by 4 ft long heavy wall glass column is used to contain an approximately 3 ft soil column sample. A porous ceramic plate located at a bottom of the soil column collects the leachate discharging the soil column. A porous ceramic plate located on top the soil column provides a uniform distribution of water over the entire cross-section of the soil column. Teflon/PVC end caps are clamped to the top and bottom of the glass column using all-thread rods and nuts. Teflon and Viton o-rings seal the end caps to the glass column. Water is applied to the top of the soil column which is mounted vertically on a wooden rack. The water infiltrates downward through the soil column and discharges as leachate from the bottom. The water column will be kept saturated (maintaining a water layer above the soil) to prevent oxygenation of the soil layer.

A volumetrically graduated two gallon plexiglass reservoir is used to contain, deliver, and meter the water under pressure to the soil column. Nitrogen gas is used to pressurize the reservoir. The water reservoir is refilled as required using vacuum to draw the stock water from a 55-gallon polyethylene drum.

The leachate discharging from the soil column is collected in a 4 liter glass beaker, 2 liter glass buret, or a 100 milliliter glass buret depending on the leachate sample type and quantity being collected. Note that the 100 ml buret is used to grab the volatile organic sample and is equipped with a vapor trap to minimize the loss of volatiles during collection. Valves and tubing used to convey and route the permeant or leachate are constructed of stainless steel and Teflon materials.

Once the test conditions and test parameters are defined for the soil sample, the test apparatus will be assembled and leak checked. Soil samples will be removed from the storage containers and compacted into the flask columns at the target dry density. The bottom end plate and o-ring will be attached to the bottom of the glass column and then a porous ceramic disc will be placed on top of the bottom end plate. The soil will be

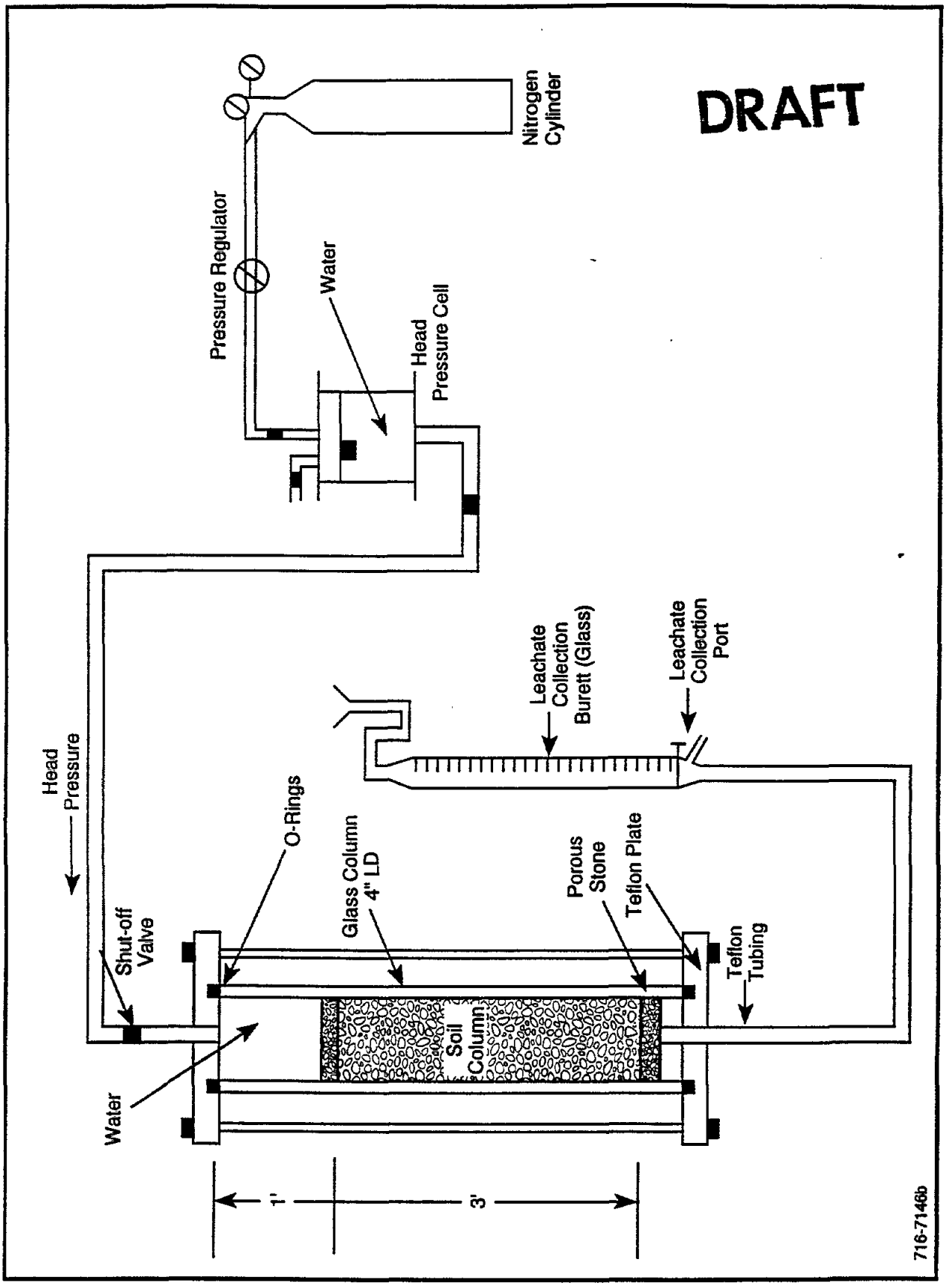

FIGURE 4-1 SCHEMATIC OF SOIL COLUMN TEST APPARATUS

compacted in 3 inch lifts using a 2.5 kilogram cylindrical weight dropped from a constant height of 12 inches. The soil density of each lift will be controlled by varying the soil weight and number of drops applied by the compaction weight. The soil density of each lift will be monitored by measuring the incremental soil weight and volume loss with a pan balance and measuring tape. After the soil column compaction procedure is complete, the total weight, height, and volume of the soil column will be recorded and used to calculate the average soil density and porosity.

During the soil compaction procedure, grab samples of soil representing each lift will be taken for analysis for chlorinated benzenes.

The top end plate and o-ring will be attached to the top of the glass column and the all-thread rods securely tightened to seal the top and bottom end plates. The column inlet and outlet valves will then be closed and the column will be leak-checked at a pressure of 40 pounds per square inch (psi). If any leaks are detected, the problem will be corrected before continuing. The water supply line will then be attached to the top end plate of the soil column and the leachate collection line will be attached to the bottom end plate.

The column leach test will be started by applying water to the soil column and allowing the permeant to infiltrate through the soil without using applied pressure. As the leachate discharges from the soil column, total cumulative values, pH, COD, and specific conductance of the leachate will be measured and recorded. If required, pressure will be applied to the soil column to accelerate the permeation rate. However, the maximum test permeation rate will not be allowed to exceed the natural permeability of the soil by one order-of-magnitude.

Samples will be collected at the beginning, midpoint, and completion of the column study to be analyzed for chlorinated benzenes. The laboratory will monitor pH, specific conductance, and COD frequently throughout the testing. The leachate will be collected in one liter beakers, combined and mixed before splitting into aliquots for chemical analysis.

The permeability of the soil column will be measured at the beginning, the midpoint, and at the end of the study just before column dismantling. Permeability will be measured directly in the soil column using tap water as the fluid.

The column study will be terminated after the equivalent 10-year sample is collected, or 60 test days have passed. After the final permeability measurement is performed and the leachate discharge has stopped, each soil column height will be measured. The columns will then be dismantled and the soil recovered and weighed.

Grab samples of the final soil will be collected for chlorinated benzene analysis. Samples will be obtained in the same numbers and column locations as carried out at the beginning of the study.

The test matrix for column testing is presented in Table 4-2. Triplicate analyses of chlorinated benzenes in soils will be conducted for statistical evaluation.

4.2.3 Methanotrophic Option

Based upon recent literature on the potential field application of methane to stimulate biotransformation of chlorinated organics, consideration will be given to supplementing the column study by addition of dissolved methane to the infiltrated water, based upon the approach of Lanzarene and McCarty[8].

Table 4-2

Soil Column Test Matrix

Column	Water Sampling Inlet and Outlet	Soil Sampling[1]
Test Column	T = 0, 10, 30, 60 days	T = 0, 60 days
Control Column	T = 0, 10, 30, 60 days	T = 0, 60 days

[1]Triplicate analyses for chlorinated benzenes at each sample interval by SCD.

SECTION 5

SAMPLING AND ANALYSIS

5.1 FIELD SAMPLING

To provide the soil required for the laboratory tests, soil samples will be obtained from the site. As indicated, samples will be collected from surface soils, subsurface soils, and sediments. All sampling will be conducted in accordance with the protocols identified in the Quality Assurance Project Plan (QAPjP)[10].

5.1.1 Surface Soil Sample

The average total concentration (total SCD analytes) of investigated onsite and offsite surface soils are approximately 4,500 and 3,700 mg/kg respectively. The surface soil for this testing program will be obtained from an area where soil concentrations are close to these averages. A surface soil sample collected at a depth of 12 inches below ground surface from the eastern drainage ditch (along the 1986 release pathway) is expected to have the targeted soil concentrations. The sample location will be near sample SS-36 as taken during the RI. RI sample analysis from SS-36 showed total concentrations of 3,665 mg/kg at a depth of 12 to 18 inches below ground surface.

5.1.2 Subsurface Soil Sample

The average total concentration of investigated subsurface soils is approximately 1,000 mg/kg (not including Catch Basin No. 1). Therefore, the subsurface soil will be collected from an area where the soil concentration are close to this average. The subsurface soil for this treatability study will be collected from a depth of 4 to 5 ft in the area of RI soil sample location SS-31. Sample analysis from SS-31 showed total concentrations of 633 mg/kg at a depth of 4 to 5 feet. The sample for the column test, which includes a Shelby tube and approximately 50 pounds of bulk soil, will also be taken from this location.

5.1.3 Sediment Sample

The target concentration for the sediment sample is 100 mg/kg. This will enable the treatability study to evaluate the treatability of sediment, and also allow for the evaluation of treatability at lower concentrations than those for the surface and subsurface soil sample. The sediment sample will be collected at a depth of 0 to 6 inches from a location near SSX-11, as taken during the RI. Sample SSX-11 showed total concentrations of 94.7 mg/kg at a depth of 0 to 6 inches.

5.2 TREATABILITY TESTING PARAMETERS AND METHODS

The chemical and physical analysis to be performed on water and soil samples during treatability tests are presented in Table 5-1 and 5-2. The test methods used for the chemical and physical analysis are also referenced in these tables. Sample containers, preservation, and holding time requirements for chemical analyses are provided in Tables 5-3 and 5-4.

5.3 QA/QC AND DATA MANAGEMENT

Field and laboratory sampling and analytical procedures will comply with QA/QC protocols established under the QAPjP. Treatability laboratory activities associated with all tests will be documented. Bound notebooks will be used to record raw data and observations in the laboratory. Data collection sheets will also be used to record information during some of the tests. Chain-of-custody documentation will be used to ship samples to the various testing laboratories which may be utilized.

Table 5-1

Summary of Aqueous Sample Analytical Parameters and Test Methods

Analytical Parameters	Test Method Reference
pH (1)	USEPA-9040
Nitrogen (TKN and Ammonia) (1)	MCAWW 351.4/350.3
Total Phosphorous (1)	MCAWW 365.2
COD (1)	MCAWW 410.2/410.4
Chlorinated benzenes (2)	As identified in the QAPjP(10)

(1) Analyses by WESTON Eastern U.S. Analytical Laboratory.
(2) Analyses by Standard Chlorine of Delaware (SCD) Laboratory.

Table 5-2

Summary of Soil Sample Analytical Parameters and Test Methods

Analytical Parameters	Test Method Reference
Soil pH (lab method) (1)	ASTM D2976-71
Bulk Density of Undisturbed Soil (1)	ASTM D2937-83
Hydraulic Conductivity - Flexi Wall (1)	USEPA 9100
Soil Moisture Content (1)	ASTM D2216-80
Porosity (bulk density and specific gravity) (1)	Calculated
Grain Size Distribution (1)	ASTM D422
Nitrogen (TKN and Ammonia) (2)	
Total Phosphorus (2)	
Chlorinated benzenes (3)	As identified in the QAPjP(10)

(1) Analyses by WESTON Environmental Technology Laboratory.
(2) Analyses by WESTON Eastern U.S. Analytical Laboratory.
(3) Analyses by Standard Chlorine of Delaware (SCD) Laboratory.

Table 5-3

Sample Containers, Sample Volumes, Preservations, and Holding Times for Aqueous Samples

Aqueous Samples			
Analyte	Container	Preservation	Holding Time[a]
NH_4-N, TKN	P	H_2SO_4 pH<2, cool, 4°C	28 days
NO_3-N	P	Cool, 4°C	48 hours
PO_4-P	P	H_2SO_4 pH<2, cool, 4°C	28 days
Chlorinated Benzenes[b]			

P = Polyethylene
[a] This is the maximum holding time for date of collection.
[b] As identified in the QAPjP[10].

Table 5-4

Sample Containers, Sample Volumes, Preservations, and Holding Times for Soil Samples

Soil Samples			
Analyte	Container	Preservation	Holding Time[a]
NH_4-N, TKN	G, amber	Cool, 4°C	28 days
NO_3-N	G, amber	Cool, 4°C	48 hours
PO_4-P	G, amber	Cool, 4°C	28 days
Chlorinated Benzenes[b]			

G = Glass

[a] This is the maximum holding time for date of collection.

[b] As identified in the QAPjP[10].

SECTION 6

DATA MANAGEMENT

6.1 ANALYTICAL DATA

All analytical data will be tracked to ensure completion and receipt of all requested analyses. Upon receipt of data packages from the analytical laboratory, analytical data will be transcribed and summarized in spreadsheet form suitable for subsequent manipulation (e.g., statistical evaluations) and presentation. All original data packages will be maintained with project files.

6.2 OPERATING DATA

All operating data taken during the course of the study will be recorded chronologically in bound laboratory notebooks by laboratory technicians conducting the study. Examples of such data include, but are not limited to, operating readings taken with direct reading instruments (temperature, pH, etc.). The notebook will also be used to keep a chronological narrative record of experimental activity such as, but not limited to, date and time of sampling, machine calibrations and unusual events or problems such as mechanical breakdowns which may affect data interpretation. Entries will be initialed by the operator. Laboratory notebooks will be retained in project files following completion of the study.

SECTION 7

DATA ANALYSIS AND INTERPRETATION

The experimental data will be analyzed to determine the potential effectiveness of biodegradation processes in treating the SCD site soils and sediments. The treatability and analytical data will be summarized in tabular and graphical form for ease of evaluation. The primary focus of the data analysis will be to evaluate the destruction or biotransformation of chlorinated benzenes. Results of the testing program will be summarized to characterize the soil to determine contaminant removal effectiveness under the various test conditions.

Changes in total chlorinated benzenes as well as distribution among chlorinated benzenes forms will be determined to assess biotransformation/biodegradation. Analyses for chloride will be used to check the degree of transformation achieved. Nutrient analyses will be used to verify the maintenance of test conditions. Performance will be assessed in the amended treatments as compared to the inhibited control.

Operating data will be used to evaluate experimental procedures and controls and to qualitatively assess experimental observations. In addition, operating data from on-line instrumentation will be used during the experimental phase to adjust and refine, as necessary, experimental and environmental settings.

Data from the testing will be compiled in tabular or graphical form as appropriate. These will be suitable for working session presentation to the EPA and the DNREC. If the testing shows that bioremediation is viable, the results may be compiled into an FS addendum, but this is not included in this test program.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SECTION 8

HEALTH AND SAFETY

Field activities will be conducted in accordance with the existing Health Safety Plan (HASP)[11]. The bioremediation treatability testing will be conducted in accordance with WESTON's Environmental Test Laboratory's (ETL) standard HASP. This plan addresses normal laboratory safety procedures, training, organization, waste disposal, and emergency response, and is in accordance with 29 CFR 1910.1450, OSHA's "Occupational Exposure to Hazardous Chemicals in Laboratories." The plan specifies that additional safety procedures will be required for work that has unusual or extraordinary safety risks.

SECTION 9

RESIDUALS MANAGEMENT

All unused bulk samples and testing residuals will be stored in the shipping containers and placed in designated curbed areas within the treatability laboratory. These curbed areas will have sufficient capacity to contain the volume of the largest sample container, and will be impervious to spills and leaks. At the completion of the treatability study, all residuals will be properly disposed of in accordance with applicable regulations.

WESTON
MANAGERS DESIGNERS/CONSULTANTS

SECTION 10

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11. Roy F. Weston, Inc., "Health and Safety Plan," prepared for Standard Chlorine of Delaware, August 1989.